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IS 7429 (1974): Procedure for inspection and testing of aluminium and aluminium alloy extruded bars, rods and sections (for aircraft purposes) [MTD 7: Light Metals and their Alloys]

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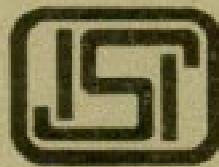
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Indian Standard
PROCEDURE FOR
INSPECTION AND TESTING OF
ALUMINIUM AND ALUMINIUM ALLOY
EXTRUDED BARS, RODS AND SECTIONS
(FOR AIRCRAFT PURPOSES)

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110001

Indian Standard
 PROCEDURE FOR
 INSPECTION AND TESTING OF
 ALUMINIUM AND ALUMINIUM ALLOY
 EXTRUDED BARS, RODS AND SECTIONS
 (FOR AIRCRAFT PURPOSES)

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(Continued on page 20)

Indian Standard

PROCEDURE FOR
INSPECTION AND TESTING OF
ALUMINIUM AND ALUMINIUM ALLOY
EXTRUDED BARS, RODS AND SECTIONS
(FOR AIRCRAFT PURPOSES)

0. F O R E W O R D

0.1 This Indian Standard was adopted by the Indian Standards Institution on 22 July 1974, after the draft finalized by the Light Metals and Their Alloys Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard has been prepared to cover general inspection and testing requirements for wrought aluminium and aluminium alloy extruded bars and rods (for machining) and sections (hereafter referred to as bars, rods and sections) used in aircraft manufacture.

0.3 In the formulation of this standard, due weightage has also been given to international co-ordination among standards and practices prevailing in different countries in addition to the practices followed in the field in this country. This has been met by deriving assistance from the following specifications :

BS 3L100 : 1971 Procedure for inspection and testing of wrought aluminium and aluminium alloys. British Standards Institution.

GOST 4783-1968 Extruded aluminium and aluminium alloy rods. Gosudarstvennyj Komitet Standartov, Mer i Izmeritel'nyh Priborov SSSR (USSR).

AIR 9050C-1960 Aluminium alloy products — Acceptance requirements. Association Française de Normalisation (France).

0.4 This standard contains clauses **2.11, 3.2, 6.1, 6.1.2.2** (Table 4), **6.1.3.2, 6.1.6.2, 8.2.2.3, 10.1.1, 10.1.6.1, 10.1.6.2** and **10.3.2.3** which call for agreement between the manufacturer/supplier and the purchaser.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers procedure for inspection and testing of aluminium and aluminium alloy extruded bars and rods for machining, and sections for aircraft purposes.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Approved Scrap — Scrap which is:

- a) derived from material the composition of which has been established with regard to the complete range of both the alloying elements and impurity elements appropriate to the class of alloy being made, and
- b) segregated and identifiable to the satisfaction of the Inspecting Authority (Indian Airworthiness Authority).

2.2 Bar — Any solid section other than round, whose width or greatest distance between parallel faces is greater than 6 mm.

2.3 Rod — Any round solid section with a diameter greater than 6 mm.

2.4 Billet — A cylindrical or rectangular casting used for subsequent working.

2.5 Controlled Stretching — Stretching to effect a specified permanent extension (percentage permanent set) in order to relieve internal stresses and to minimize distortion during machining.

2.6 Extruded Length — The length produced from one cast billet or if a multihole die is used, each length produced from one cast billet.

2.7 Extruded Section — A length of extruded material not covered by the term 'bar' as defined in **2.2** nor in the form of tube or wire.

2.8 Harmful Defects — Any defect prejudicial to the subsequent manufacture, fabrication or use of the material (*see Appendix A*).

2.9 Inspector — The individual responsible for the executive inspection and release of material. This term shall be interpreted in any manner directed by the Inspecting Authority.

2.10 Inspecting Authority — The body responsible for authorizing the manufacturer or supplier to issue certificates.

2.11 Inspection Schedule — A schedule of any special test requirements agreed to between the manufacturer/supplier and the purchaser.

3. CONDITION

3.1 Bars, rods and sections which are not subjected to solution treatment should be delivered in any condition stipulated in the material specification.

3.2 Bars*, Rods and Sections Hardenable by Heat Treatment — Grade I for General Applications and Grade II for Highly Stressed Structures — Bars, rods and sections should be delivered in any condition stipulated in the material specifications and according to the grade wherever applicable. Any other condition required by the purchaser should be agreed to between the manufacturer/supplier and the purchaser and should be stated on the order together with the required grade, if applicable.

3.3 Grade II material should be controlled stretched to a permanent extension of not less than 1.5 percent nor more than 2.5 percent.

4. CERTIFICATION

4.1 The manufacturer should supply to the purchaser the necessary certificates in respect of all materials governed by this standard and the material specification.

4.2 Except as provided in **4.3**, if any certificate is issued by a supplier other than the manufacturer, such supplier should hold the equivalent certificate issued by the manufacturer of the material.

4.3 If a batch of material consigned by the manufacturer is subdivided by an approved non-manufacturer, before reconsignment, the non-manufacturer should carry out any consequent additional dimensional inspection and identification marking and should certify accordingly.

5. FREEDOM FROM DEFECTS

5.1 The material should be free from harmful defects. Some of the defects generally encountered are listed in Appendix A.

5.2 Any material should be rejected for faults in manufacture although it may have been passed on chemical composition and mechanical tests.

6. DIMENSIONAL TOLERANCES

6.1 Unless special tolerances are agreed to between the manufacturer/supplier and the purchaser, the dimensions of the material should comply with the appropriate requirements given in **6.1.1** to **6.1.6**.

6.1.1 Length, Thickness and Diameter — Length, thickness and diameter of bars, rods and regular sections should comply with the requirements of Tables 1, 2 and 3 respectively.

*If no grade is mentioned in the material specification, it should be considered as Grade I for inspection and testing requirements.

**TABLE 1 TOLERANCE ON LENGTHS OF BARS, RODS AND
REGULAR SECTIONS**

(Clause 6.1.1)

All dimensions in millimetres.

NOMINAL DIAMETER, OVERALL WIDTH OR WIDTH ACROSS FLATS	LENGTH	OVER	OVER	OVER	OVER	OVER	OVER
		299	1 000	1 500	5 000	7 000	10 000
		UPTO	UPTO	UPTO	UPTO	UPTO	
		1 000	1 500	5 000	7 000	10 000	
Over	Up to and Including	TOLERANCE ON LENGTH					
—	60	±2·0	±2·5	±2·5	±3·5	±4·0	± 6·5
60	100	±2·0	±2·5	±3·5	±4·0	±5·5	± 7·5
100	140	±3·0	±3·5	±4·0	±5·0	±6·5	± 8·0
140	180	±3·5	±4·0	±5·0	±6·5	±8·0	± 9·5
180	240	±4·5	±5·0	±6·5	±8·0	±9·5	±11·0

6.1.2 Width

6.1.2.1 The overall width and width across flats of bars (except hexagonal bars for bolts and nuts) and regular sections should comply with the appropriate requirements of Table 3.

6.1.2.2 Width across flats of hexagonal bars for the manufacture of bolts and nuts should comply with the requirements of Table 4.

6.1.2.3 The internal and external dimensions of open end channel and I-beam should comply with the requirements of Table 5.

6.1.3 Straightness

6.1.3.1 Straightness of the bars, rods and regular sections should comply with the requirements of Table 6.

6.1.3.2 Any special tolerances required should be agreed to between the purchaser and the manufacturer/supplier and should be stated on the order, drawing or inspection schedule.

6.1.4 *Twist (Not Binding on Materials in 3.1)* — The twist on extruded sections should comply with the requirements of Table 7.

6.1.5 *Concavity and Convexity (Not Binding on Materials in 3.1)* — A maximum tolerance on concavity and convexity of 0·05 mm per 10 mm should apply over the width of the flat faces of bars and sections.

6.1.6 Angles (*Not Binding on Materials in 3.1*)

6.1.6.1 The angles of regular sections should comply with the requirements of Table 8.

TABLE 2 TOLERANCES ON THICKNESS OF BARS, RODS AND REGULAR SECTIONS

(Clause 6.1.1)

All dimensions in millimetres.

THICKNESS NOMINAL WIDTH		UP TO 1·6	OVER 1·6 UP TO 3	OVER 3 UP TO 6	OVER 6 UP TO 10	OVER 10 UP TO 18	OVER 18 UP TO 30	OVER 30 UP TO 40	OVER 40 UP TO 60	OVER 60 UP TO 80	OVER 80 UP TO 100	OVER 100 UP TO 120	OVER 120 UP TO 140	OVER 140 UP TO 160*
Over	Up to and Includ- ing	TOLERANCE ON THICKNESS												
—	10	±0·16	±0·18	±0·20	±0·22	—	—	—	—	—	—	—	—	—
10	18	±0·18	±0·20	±0·22	±0·24	±0·26	—	—	—	—	—	—	—	—
18	30	±0·22	±0·24	±0·26	±0·28	±0·30	±0·32	—	—	—	—	—	—	—
30	60	±0·24	±0·26	±0·28	±0·30	±0·33	±0·36	±0·40	—	—	—	—	—	—
60	80	±0·28	±0·30	±0·32	±0·34	±0·37	±0·40	±0·43	±0·45	±0·50	—	—	—	—
80	120	±0·32	±0·34	±0·36	±0·39	±0·42	±0·45	±0·48	±0·52	±0·57	±0·65	±0·80	—	—
120	180	—	±0·36	±0·40	±0·45	±0·50	±0·55	±0·60	±0·65	±0·70	±0·75	±0·82	±0·90	±1·0
180	240	—	—	±0·50	±0·55	±0·60	±0·65	±0·70	±0·75	±0·80	±0·85	±0·90	±0·95	±1·05
240	320	—	—	±0·60	±0·65	±0·70	±0·75	±0·80	±0·85	±0·90	±0·95	±1·0	±1·05	±1·1

*For thickness over 160 mm the tolerances in Table 3 for comparable widths should apply.

**TABLE 3 TOLERANCES ON DIAMETERS, OVERALL WIDTHS AND
WIDTHS ACROSS FLATS OF BARS, RODS (OTHER THAN
THOSE COVERED BY TABLE 4) AND REGULAR SECTIONS**

(*Clauses 6.1.1 and 6.1.2.1*)

All dimensions in millimetres.

NOMINAL DIAMETER, OVERALL WIDTH OR WIDTH ACROSS FLATS	Over	Up to and Including	TOLERANCE					
			Rods for Machining (Automatic Lathes)		Controlled Stretched Rods		Other Bars and Regular Sections Plus and Minus	
			Plus	Minus	Plus	Minus		
—	3	—	—	—	—	—	0.16	
3	10	—	—	—	—	—	0.20	
10	18	0.05	0.10	0.05	0.20	0.26		
18	30	0.08	0.13	0.08	0.26	0.32		
30	40	0.14	0.14	0.14	0.28	0.40		
40	60	0.20	0.20	0.20	0.40	0.45		
60	80	0.30	0.30	0.30	0.60	0.50		
80	100	0.40	0.40	0.40	0.80	0.65		
100	120	0.50*	0.50*	0.50*	1.00*	0.80		
120	140	0.50*	0.50*	0.50*	1.00*	0.90		
140	160	0.50*	0.50*	0.50*	1.00*	1.00		
160	180	—	—	—	—	—	1.10	
180	200	—	—	—	—	—	1.20	
200	240	—	—	—	—	—	1.30	
240	280	—	—	—	—	—	1.50	
280	320	—	—	—	—	—	1.70	

*Percent of diameter.

TABLE 4 TOLERANCES ON WIDTHS ACROSS FLATS OF HEXAGONAL BARS FOR NUTS AND BOLTS

(Clause 6.1.2.2)

All dimensions in millimetres.

NOMINAL SIZE OF BAR	WIDTH ACROSS FLATS	
	Max	Min
3·2	3·20	3·12
4·0	4·00	3·92
5·0	5·00	4·90
5·5	5·50	5·40
7·0	7·00	6·90
8·0	8·00	7·90
10·0	10·00	9·90
11·0	11·00	10·90
12·0	12·00	11·90
13·0	13·00	12·90
14·0	14·00	13·90
17·0	17·00	16·90
19·0	19·00	18·90
22·0	22·00	21·87
24·0	24·00	23·87
27·0	27·00	26·87
30·0	30·00	29·87
32·0	32·00	31·87
36·0	36·00	35·87
41·0	41·00	40·85
46·0	46·00	45·85
50·0	50·00	49·80
55·0	55·00	54·80
60·0	60·00	59·80
Over 60·0	Subject to agreement between the manufacturer/supplier and the purchaser	

NOTE — Hexagonal bars for purposes other than nuts and bolts are tolerated as for regular sections.

TABLE 5 TOLERANCES ON OPEN ENDS OF CHANNELS AND I-BEAMS

(Clause 6.1.2.3)

All dimensions in millimetres.

DEPTH		MINIMUM THICKNESS OF WEB OR FLANGE		UP TO 10	OVER 10 UP TO 18	OVER 18 UP TO 30	OVER 30 UP TO 40	OVER 40 UP TO 60	OVER 60 UP TO 80	OVER 80 UP TO 100	OVER 100 UP TO 120	OVER 120 UP TO 140	OVER 140 UP TO 160	OVER 160 UP TO 180
OVERALL WIDTH OF CHANNEL	Up to and Including	Ovcr	Up to and Including											
TOLERANCE ON INTERNAL OR EXTERNAL DIMENSIONS AT THE TOP OF GAP														
10	Up to and Including	Ovcr	Up to and Including											
	10	— 1·5 3	1·5 3 —	±0·25 ±0·23 ±0·22	±0·32 ±0·28 ±0·26	±0·41 ±0·34 ±0·30	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —
10	18	— 1·5 3	1·5 3 —	±0·31 ±0·29 ±0·27	±0·38 ±0·34 ±0·32	±0·47 ±0·40 ±0·36	±0·56 ±0·46 ±0·41	±0·70 ±0·55 ±0·47	— — —	— — —	— — —	— — —	— — —	— — —
18	30	— 3 6	3 6 —	±0·37 ±0·37 ±0·35	±0·47 ±0·44 ±0·41	±0·57 ±0·53 ±0·48	±0·66 ±0·62 ±0·55	±0·84 ±0·76 ±0·64	±1·05 ±0·93 ±0·78	±1·26 ±1·11 ±0·91	— — —	— — —	— — —	— — —
30	40	— 3 6	3 6 —	±0·45 ±0·45 ±0·43	±0·55 ±0·52 ±0·49	±0·65 ±0·61 ±0·56	±0·76 ±0·70 ±0·63	±0·92 ±0·84 ±0·72	±1·13 ±1·01 ±0·86	±1·34 ±1·19 ±0·99	±1·55 ±1·36 ±1·12	±1·76 ±1·54 ±1·25	— — —	— — —

40	60	— 3 6	3 6	—	±0.60 ±0.57 ±0.54	±0.70 ±0.66 ±0.61	±0.81 ±0.75 ±0.68	±0.97 ±0.89 ±0.77	±1.18 ±1.06 ±0.91	±1.39 ±1.24 ±1.04	±1.60 ±1.41 ±1.17	±1.81 ±1.59 ±1.30	±2.02 ±1.76 ±1.43	— — —
60	80	— 3 6	3 6	—	±0.65 ±0.62 ±0.59	±0.75 ±0.71 ±0.66	±0.86 ±0.80 ±0.82	±1.02 ±0.94 ±0.96	±1.23 ±1.11 ±1.09	±1.44 ±1.29 ±1.09	±1.65 ±1.46 ±1.22	±1.86 ±1.64 ±1.35	±2.07 ±1.81 ±1.48	±2.88 ±1.99 ±1.61
80	100	— 6	6 —	—	— —	±0.90 ±0.86	±1.01 ±0.95	±1.17 ±1.09	±1.38 ±1.26	±1.59 ±1.44	±1.80 ±1.61	±2.01 ±1.79	±2.22 ±1.96	±2.43 ±2.14
100	120	— 6	6 —	—	— —	±1.05 ±1.01	±1.16 ±1.10	±1.32 ±1.24	±1.53 ±1.41	±1.74 ±1.59	±1.95 ±1.76	±2.16 ±1.94	±2.37 ±2.11	±2.58 ±2.29
120	140	— 6	6 —	—	— —	±1.15 ±1.11	±1.26 ±1.20	±1.42 ±1.34	±1.63 ±1.51	±1.84 ±1.69	±2.05 ±1.86	±2.26 ±2.04	±2.47 ±2.21	±2.68 ±2.39
140	160	— 6	6 —	—	— —	±1.25 ±1.21	±1.36 ±1.30	±1.52 ±1.44	±1.73 ±1.61	±1.94 ±1.79	±2.15 ±1.96	±2.36 ±2.14	±2.57 ±2.31	±2.78 ±2.49
160	180	— 6	6 —	—	— —	±1.35 ±1.31	±1.46 ±1.40	±1.62 ±1.54	±1.83 ±1.71	±2.04 ±1.89	±2.25 ±2.06	±2.46 ±2.24	±2.67 ±2.41	±2.88 ±2.59
180	200	— 6	6 —	—	— —	±1.45 ±1.41	±1.56 ±1.50	±1.72 ±1.64	±1.93 ±1.81	±2.14 ±1.99	±2.35 ±2.16	±2.56 ±2.34	±2.77 ±2.51	±2.98 ±2.69
200	240	— 6	6 —	—	— —	±1.55 ±1.51	±1.66 ±1.60	±1.82 ±1.74	±2.03 ±1.91	±2.24 ±2.09	±2.45 ±2.26	±2.66 ±2.44	±2.87 ±2.61	±3.08 ±2.79
240	280	6	—	—	— —	±1.71	±1.80	±1.94	±2.15	±2.29	±2.46	±2.64	±2.81	±2.99
280	320	6	—	—	— —	±1.91	±2.00	±2.14	±2.31	±2.49	±2.66	±2.84	±3.01	±3.19

TABLE 6 TOLERANCES ON STRAIGHTNESS OF BARS, RODS AND REGULAR SECTIONS

(Clause 6.1.3.1)

DIAMETER*	DEPARTURE FROM STRAIGHTNESS OVER ANY SELECTED LENGTH OF 1 000 mm
mm	mm
Up to 100	1.5
Over 100	2.5

*Round bar: Nominal diameter.

Section: Diameter of circumscribing circle.

TABLE 7 TOLERANCES ON TWIST OF EXTRUDED SECTIONS

(Clause 6.1.4)

DIAMETER OF CIRCLE CIRCUMSCRIBING THE SECTION	ANGLE OF TWIST PER 300 mm RUN, Max		PERMISSIBLE TWIST PER LENGTH, Max	
	Degrees	At Extremity mm	Degrees	At Extremity mm
mm				
Under 40	1	0.7	5	7
40 up to and including 80	½	0.7	3	8
Over 80:				
Lengths up to and including 8 000	¼	0.52	2	8
Over 8 000	¼	0.52	3	8

TABLE 8 TOLERANCES ON ANGLES OF REGULAR SECTIONS

(Clause 6.1.6.1)

NOMINAL THICKNESS OF THINNEST
RECTANGLE OF THE SECTION
mm

Up to and including 1.6	±2°
Over 1.6 up to and including 5.0	±1½°
Over 5.0	±1°

ALLOWABLE DEVIATION
FROM ANGLE SPECIFIED

6.1.6.2 The tolerances on angles of the other sections should be agreed to between the manufacturer/supplier and the purchaser and should be stated on the order.

7. CHEMICAL COMPOSITION

7.1 The chemical composition of the material should comply with the requirements of the material specification. The value stipulated in the specification should be applied in accordance with the instructions of the Inspecting Authority. Elements not quoted in the specification should not be added for any purpose other than fluxing, degassing, grain-refinement and the like. The overall control of the chemical composition and the regulation for the use of scrap should be such that the method of analytical control adopted for each particular material should enable the inspector to certify compliance with the requirements.

7.2 The manufacturer should make an entry of the melt and the chemical composition as and when regular lots are melted in his melt register.

7.3 Analysis of the alloys need be carried out on finished products only in case of dispute.

8. SELECTION OF MECHANICAL TEST SAMPLES

8.1 For Materials not Subjected to Solution Treatment

8.1.1 Bars, rods and sections of the same nominal cross-sectional dimensions from the same cast, in the same material specification, and if annealed that have been annealed together, should be grouped in batches as :

<i>Nominal Diameter or Major Sectional Dimensions</i>		<i>Maximum Size of Batch</i>	
<i>Over</i>	<i>Up to and Including</i>		
mm	mm	kg	
—	10	500*	
10	20	1 000	
20	50	1 500	
50	—	2,000	

8.1.2 The inspector should select one test sample from a bar, rod or section in each batch for the specified tensile test (see 10.1.1).

8.2 Solution Treated and Precipitation Treated Material

8.2.1 Bars, rods and sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition, that is, controlled stretched or non-controlled stretched and if annealed that have been annealed together should be grouped in batches.

* or 3 000 metres whichever is lesser mass.

8.2.1.1 The inspector should select one test sample from a bar, rod or extruded section in each batch for the specified tensile test (10.1).

8.2.2 Material Solution-Treated and Aged at Room Temperature Including Those to be Precipitation-Treated After Delivery

8.2.2.1 Bars, rods and sections of the same nominal cross-sectional dimensions, from the same cast, in the same condition, that is, controlled stretched or non-controlled stretched and that have been heat-treated together, should be grouped in batches.

8.2.2.2 For Grade I materials, inspector should select one test sample from a bar, rod or section in each batch for tensile test. It should be selected from the extruded length of lowest hardness at the option of the manufacturer.

8.2.2.3 For Grade II materials, inspector should select one or more test samples from each extruded length. The locations of the test samples and the number of samples to be taken from each extruded length should be agreed to between the manufacturer/supplier and the purchaser and should be stated on the drawing, order or inspection schedule.

9. PREPARATION OF MECHANICAL TEST SPECIMENS

9.1 Test samples selected in accordance with 8.1 should not be subjected to any thermal treatment or mechanical working except in the preparation of test specimens, after they have been separated from the material they represent.

9.2 Test samples selected in accordance with 8.2, if not delivered in the required condition, should be solution treated and aged at room temperature, solution-treated and precipitation-treated or precipitation-treated only, in full cross section, to obtain the required condition specified in the material specification and should not be further subjected to any thermal treatment or mechanical working except in the preparation of test specimens after they have been separated from the material they represent.

10. MECHANICAL TEST

10.1 Tensile Test

10.1.1 The test specimens should be tested in accordance with the requirements of IS : 1816-1961* with a gauge length of $5.65\sqrt{S_0}$, where S_0 is the original cross-sectional area within the gauge length. The secondary methods of proof stress verification may be employed and the values obtained should comply with the requirements of the required condition specified in the material specification or if appropriate, with requirements agreed to between the manufacturer/supplier and the purchaser in accordance with this

*Method for tensile test for light metals and their alloys.

standard. The values stipulated in the specification should be applied in accordance with the instructions of the Inspecting Authority.

10.1.2 The test samples should be selected and identified as directed by the inspector before they are separated from the material.

10.1.3 Except as provided in **10.1.4**, the test specimens should be machined from the selected test samples (**10.1.5**) to the dimensions of the largest practicable size of the proportional test specimens as given in Table 9.

TABLE 9 DIMENSIONS OF PROPORTIONAL ROUND TEST SPECIMENS
(Gauge Length = $5.65\sqrt{S_0}$)

NOMINAL CROSS-SECTIONAL AREA mm ²	DIAMETER <i>d</i> mm	GAUGE LENGTH <i>L₀</i> mm	PARALLEL LENGTH, Min <i>l_c</i> mm	RADIUS SHOULDER, Min mm
160	14.0	70	80	12.5
130	13.0	64	70	11.0
80	10.0	51	56	9.0
65	9.0	46	51	8.0
40	7.0	36	40	6.5
30	6.0	32	35	5.5
25	6.0	29	33	5.0
15	4.0	23	26	4.0
12	4.0	20	23	3.5
8	3.0	17	20	3.0

NOTE — By agreement with the Inspecting Authority, test specimens with diameter other than those given in the table may be used provided the gauge length is $5.65\sqrt{S_0}$.

10.1.4 Alternatively to **10.1.3**, at the option of the manufacturer, round square and hexagonal bar and rod not exceeding 16 mm diameter or major sectional dimensions should be tested in full section.

OR

For rectangular bars, rods and sections not exceeding 12.5 mm minor sectional dimensions in the thickest part, a test specimen of rectangular cross section should be machined with maximum available thickness and 12.5 mm width or as near 12.5 mm width as the section will permit. For these test specimens, the elongation should be measured on a gauge length of $5.65\sqrt{S_0}$ or 50 mm, at the discretion of the manufacturer. The gauge length used should be recorded on the manufacturer's test report.

10.1.5 Location of Test Specimens in the Test Sample Selected

10.1.5.1 Bar and rod — For bar and rod up to and including 50 mm diameter or minor sectional dimension, the test specimen should be machined coaxially from the test sample. For bar and rod over 50 mm diameter or

minor sectional dimension, the longitudinal axis of the test specimen shall be half-way between the central axis and the outer surface of the test sample.

10.1.5.2 Extruded section

- a) For extruded sections whose minor sectional dimension in the thickest part is not more than 50 mm, the test specimen should be machined coaxially from the thickest part of the section. The longitudinal axis of the test specimen should be equidistance from the longer sides and 25 mm (or as near 25 mm as practicable) from a shorter side of the selected part of the section.
- b) For sections whose minor sectional dimension in the thickest part is greater than 50 mm, the longitudinal axis of the test piece should be half way between the central axis and the outer surface of the thickest part of the section.

10.1.6 The tensile test specimen machined in accordance with the requirements of **10.1.5**, from the test sample selected in accordance with **8** and prepared in accordance with **9**, should satisfy the tensile test requirements of the required condition in the material specification.

10.1.6.1 Retest — If any test specimen fails to satisfy the specified tensile test requirements, the inspector should adopt the following procedures as desired by the manufacturer :

- a) Select for test, from the same batch, two further test samples, one of which should be from the bar, rod or section from which the original test sample was taken and adjacent to that sample, unless the bar, rod or section has been withdrawn by the manufacturer.
- b) Allow the batch to be re-annealed in the case of annealed materials in **8.1** or reheat-treated to the required condition in the case of materials of **8.2**.

The retest results should satisfy the tensile test requirements of the required condition in the material specification.

NOTE — For materials covered in **8.2**, if they have been hardness tested, the additional samples should be taken from a bar, rod or section of the next lowest hardness.

10.1.6.2 For Grade II bars, rods and sections, the locations, forms and sizes of the test specimen selected in accordance with **8.2** and prepared in accordance with **9**, should be agreed to between the manufacturer/supplier and the purchaser and should be stated on drawing, order or inspection schedule. If it is desired to determine the effect of peripheral coarse grains, a thin flat test piece should be used. It shall be prepared so as to include a portion of the surface of the extrusion in a location likely to have the coarsest grains, that is, back end of the extruded length.

10.1.6.3 For bars, rods and sections (both Grades I and II), the specified mechanical properties refer to the longitudinal direction and relate to test specimen machined from defined positions in the bars, rods or sections and will not necessarily be realized when tests are carried out on test specimens

selected from other positions in the material. If it is decided that tests in other directions are necessary, the required direction, locations of the test specimens and required properties should be agreed to between the manufacturer/supplier and the purchaser and should be stated on the drawing, order or inspection schedule.

10.2 Hardness Test

10.2.1 If the hardness tests are required, Brinell or Vickers hardness testers should be used.

Direct reading hardness testers, such as Rockwell hardness tester may also be used subject to the requirements of the Inspecting Authority (for Brinell tests, the ratio used for F/D^2 should be 10 for aluminium alloys unless otherwise stated in the material specifications).

10.2.2 All tests on the same batch of material, including those on test specimens should be made by the same method and under the same conditions of loading, unless otherwise authorized by the Inspecting Authority.

10.2.3 For Grade I Bars, Rods and Sections

10.2.3.1 Each bar, rod and section which has been solution-treated and aged at room temperature, solution-treated and precipitation-treated or precipitation treated only and which is of a cross section that cannot be contained in a circle of 20-mm diameter, should be hardness tested. If the bar, rod or section length is 4·5 m or more, it should be hardness tested at both ends.

10.2.3.2 Procedure for hardness testing should be as given in (a) or (b) at the option of the manufacturer :

- a) The bar, rod or section of the lowest hardness should be selected for tensile test sampling (**8.2.2.2**); and
- b) The tensile test sample should be hardness tested and the Brinell or Diamond Pyramid number of each bar, rod or section should not be less than the number, that is, X percent below the hardness number of the test specimen when X is given the appropriate value stated in the material specification. (Value of X depends upon the tensile strength of the test specimen.)

10.2.3.3 For Grade II bars, rods and sections, hardness testing is not required.

10.3 Special Tests

10.3.1 Ultrasonic Testing

10.3.1.1 For Grade I bars, rods and sections, the bars, rods and sections need be examined by ultrasonic inspection, only if required by the drawing, order or inspection schedule.

10.3.1.2 For Grade II bars, rods and sections, unless otherwise stated on the order, each bar, rod and section over 10 mm thickness should be

examined by ultrasonic inspection and the certificate should be suitably annotated.

10.3.2 Etching Test

10.3.2.1 It is applicable for Grade I materials and applicable to bars, rods, and sections that are greater in minor sectional dimensions than 5 mm and area of transverse cross section that cannot be contained in a 25-mm diameter circle. A specimen of each pattern of extrusion and each size of bar produced, in full cross section, should be selected from the back end of the extruded length, heat-treated in accordance with the required condition, suitably prepared and etched. The etched surfaces should be free from harmful defects.

10.3.2.2 If the rear end of the rear length of extruded product from a billet reveals a harmful defect, the front end of the length should be macro-etched and examined. If the front end is free from harmful defects, the other lengths from the billet may be accepted. Otherwise all lengths from the billet should be rejected.

10.3.2.3 For Grade II materials

- a) A specimen of the full transverse cross section should be taken from the back end of each extruded length, suitably prepared, etched and examined. The etched surface should be free from harmful defects; and
- b) Unless otherwise agreed upon between the manufacturer and the supplier, the coarse grain envelope on bars, rods and regular sections should not exceed the following limits :

<i>Minor Dimensions mm</i>	<i>Limits for Coarse Grain Envelope of Major Dimensions mm</i>				
	10-25	26-50	51-75	76-125	126-175
10 to 25	3	3	3	5	5
26 „ 50	—	3	5	5	6
51 „ 75	—	—	6	6	6
76 „ 125	—	—	—	8	8
126 „ 175	—	—	—	—	8

11. IDENTIFICATION

11.1 Each bar, rod and section over 20 mm major sectional dimension, passed by the inspector should be stamped with the mark of the inspector and such other markings as should ensure full identification of the material. All stampings should be done on or near one end of the bar, rod or section. If incised markings are unsuitable, the method of marking should be stated on the order.

11.2 Bars, rods and sections not exceeding 20 mm major sectional dimension and from the same cast should be either individually marked (11.1) or at the option of the manufacturer/supplier, tied securely in bundles, each of which should have attached a durable label bearing the mark of the inspector and such other marks as should ensure full identification of the material.

12. PROTECTION OF MATERIAL BEFORE DESPATCH

12.1 Unless the order states otherwise, the material should be protected before despatch by an effective (but temporary) coatings of corrosion preventive.

A P P E N D I X A

(Clauses 2.8 and 5.1)

GENERAL DEFECTS ENCOUNTERED IN ALUMINIUM ALLOY EXTRUDED BARS, RODS AND SECTIONS

A-1. SURFACE DEFECTS

A-1.1 On visual examination (not using magnifying lens), surface of the bars, rods and sections should be clean and free from dents, nicks, scratches, cuts, cracks, blisters, blow-holes, die marks, binding marks, laminations, non-metallic inclusions, wearing, metal sticking, corrosion spots, etc.

A-1.2 The bars, rods and sections should be free from nitrate salt contamination* if present, they should be washed well and dried before acceptance.

A-1.3 The bars, rods and sections are allowed to be gently dressed and cleaned using abrasive paper to remove the minor surface defects.

A-1.4 Discolouration from heat treatment, dark and white spots without roughness, spiral bright marks, etc, due to dressing of minor defects within the dimensional tolerances, may be permitted.

A-2. STRUCTURAL DEFECTS

A-2.1 Macro and micro structures of bars, rods and sections should not show any cracks, shrinkage cavity, piping, lamination, seams, non-metallic inclusions and other discontinuities, and heat deterioration (eutectic melting, grain boundary cracks, rounding of constituents). Also, they should not reveal non-uniform coarse grained core structure nor non-concentric rings.

*In order to determine the presence of nitrate salt on the surface of bars, rods or sections, apply one drop of 0.5 percent di-phenylamine solution in sulphuric acid [Dissolve 0.5 g of di-phenylamine in 10 ml water and 25 ml concentrated sulphuric acid ($d=1.84$). Make up to 100 ml by adding sulphuric acid]. Intensive blue colour of the drop of the reagent, after 10 to 15 seconds, indicates presence of nitrate salt.

(Continued from page 2)

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IS:

23-1965 Primary (virgin) aluminium notched bars and ingots for remelting for aircraft purposes (*second revision*)
202-1966 Aluminium casting alloy ingots and castings for aircraft purposes (*second revision*)
2304-1962 Procedure for inspection and testing of light metals (aluminium and magnesium) and their alloy ingots and castings for aircraft purposes
3420-1969 Procedure for inspecting and testing of aluminium and aluminium alloys, sheet and strip (for aircraft purposes)
3435-1968 99 Percent secondary aluminium notched bars and ingots for remelting for aircraft purposes
3436-1967 Aluminium-clad aluminium alloy, sheet, strip and coil for aircraft purposes
5902-1970 Aluminium and Aluminium alloy rivet stock for cold forged rivets for aircraft purposes
5909-1970 Aluminium and aluminium-manganese alloy sheet and strip for aircraft purposes

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